III. How are Water Quality Assessments Performed?

The assessment process

A surface water is assessed based on all readily available, credible, and scientifically defensible monitoring data and information pertaining to possible numeric and narrative standards violations. Each designated use is assessed, and these assessments are combined to provide an overall water quality assessment and to determine whether the Department needs to take further actions.

In assessing surface water quality there is always a risk of concluding that a surface water is impaired when it is not, or concluding that a surface water is attaining its uses when it is actually impaired. Either of these errors involves a cost. Concluding that a surface water is impaired when it is not results in a use of resources that should be utilized elsewhere. Concluding that a surface water is not impaired when it actually is allows environmental degradation and human health threats to persist. The Impaired Water Identification Rule (A.A.C. R18-11-601 through 606) was developed to reduce both of these errors by providing a comprehensive and statistically sound method for listing a surface water.

The rest of this section describes the details of the assessment process.

Data Conflicts and Weight-of-evidence Assessments – The assessment process considers multiple environmental indicators. Each type of data (e.g., biological, toxicological, physical, and chemical) provides its own insights into the integrity and health of an aquatic system and the ability of the public to safely recreate in or use such waters. Each type of data also has different strengths and limitations. For example, chemical water samples generally evaluate and predict impacts from single pollutants, but do not capture the combined interactions of pollutants or cumulative impacts over time. Some chemicals may be found in high levels in fish tissue or sediments while available laboratory methods cannot detect their presence in the water column.

To make an assessment, apparent data conflicts must be resolved. Arizona uses a "weight-of-evidence" approach in completing assessments. The strengths and limitations of each data set are considered, looking at all of the data and exceedances in context with relevant information such as soil type, geology, hydrology, flow regime, geomorphology, natural processes, potential anthropogenic influences, characteristics of the stressors, age of the data, monitoring techniques, sampling plan, and climate.

Although multiple lines of evidence are desirable, only one line of water quality evidence may be sufficient to demonstrate that the surface water or segment is impaired or not attaining its uses.

Data or information collected during critical conditions may be considered separately from the complete dataset. A surface water may be impaired only during critical conditions such as high or low stream flow, weather conditions, or anthropogenic activities in the watershed, even though it is attaining standards during all other conditions.

Data Collection and Review – For this assessment, ADEQ reviewed all readily available surface water quality data collected during the five-year period beginning January 1998 through December 2002. Data were requested from all federal and state agencies who routinely collect water quality data, including water chemistry, sediment contamination, bioassessments, fish tissue, fish kills, weed harvesting, and physical habitat information. EPA's STORET database was queried. (STORET is EPA's storage and retrieval system for housing surface water data from federal and state agencies.) The assessment team also made an effort to track down all surface water quality data collected through permit compliance, remediation, and enforcement programs within this agency, from universities, and from volunteer monitoring programs.

Data Quality Assurance -- Data used in assessment and listing must be evaluated to determine whether they meets the credible data requirements outlined in the Impaired Water Identification Rule (A.A.C. R18-11-602). To assure that the data is credible and relevant, all water quality data are collected using a suitable Quality Assurance Plan (QAP) and site-specific Sampling and Analysis Plan (SAP) or equivalent planning documents. Chemical and toxicological samples must be analyzed in a state-licensed laboratory, federal laboratory, or other laboratory that can demonstrate procedures that are substantially equal to those required by the Arizona Department of Health Services and use methods identified in A.A.C R9-14-610 or 40 CFR Part 136.

QAPs and SAPs

A **Quality Assurance Plan** details how environmental data collection and analyses are planned, implemented, and assessed for quality during the monitoring project.

A **Sampling and Analysis Plan** describes where, why, and how samples are to be collected to ensure that data quality objectives are met and that samples are spatially and temporally representative of surface water conditions.

These requirements apply to all data used in this assessment. Quality Assurance Plans (QAP) and Sampling and Analysis Plans (SAP) must specify the use of accepted field and laboratory methods by adequately trained staff. ADEQ has QAPs and associated SAPs for each of its monitoring programs that are available for reference by other monitoring entities and the public.

Adequate training of field and laboratory personnel is essential. ADEQ, in conjunction with Arizona Department of Health Services and Gateway Community College, provides classes in field monitoring techniques. Several other community colleges and universities also offer classes in environmental sampling techniques.

The data are reviewed for accuracy and to determine whether all data points are valid. Questionable data are flagged and eliminated from the assessment process unless they can be validated.

Some data were included in the monitoring tables that did not meet the credible data requirements. As noted in the tables, these data were not used for the final assessments, but have been included as reference information.

Data Tracking -- Surface and ground water data are stored in ADEQ's Water Quality Database and uploaded to the federal STORET database. Data uploaded to the STORET database can be queried on the internet at: http://www.epa.gov/STORET. ADEQ's Oracle based system is the repository of all water chemistry data collected by ADEQ and by other monitoring entities under contract by ADEQ. Eventually, all water quality data used in assessments will be stored in this database.

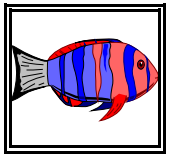
The groundwater portion of the database provides a comprehensive repository for well location information, well construction details, field measurement data (e.g., aquifer water levels), field observations (e.g., borehole geology), and water quality sampling results. The surface water portion stores sampling site information, field observations and measurements, and water quality sampling results. Further information concerning the Oracle database can be obtained by calling Wayne Hood, Data Management and Analysis Section Manager at (602) 771-4427.

Do all waters have to meet the same standards?

Standards and Designated Uses -- Arizona sets narrative and numeric surface water standards for water quality based on the uses people and wildlife make of the water. These "designated uses" are specified in the standards for individual surface waters, or if the surface water is not listed in the rule, the designated uses are determined by the tributary rule. Surface waters have multiple designated uses, while aquifers are protected for drinking water use, unless specifically reclassified. Water quality is judged acceptable or impaired based on standards established to protect each designated use.

Designated Use Classification -- Six groups of designated uses can be applied to surface waters. All bodies of water regulated by these standards (except canals) are protected for aquatic and wildlife uses and recreation in or on the water (either Full Body and Fish Consumption or Partial Body Contact).

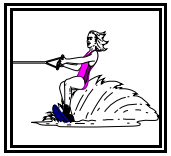
1. **Aquatic and Wildlife**. Four categories of aquatic and wildlife protection have been established. All surface waters, except canals, have one of these:



   < Warmwater aquatic community (A&Ww),
   < Coldwater aquatic community (A&Wc),
   < Effluent dependent water (A&Wedw),
   < Ephemeral flow (A&We).

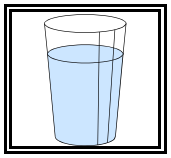
   Aquatic and Wildlife criteria (except for A&W ephemeral) are also divided into acute criteria (established based on short exposures) and chronic criteria (established based on long-term or life-time exposures.)

- **Full Body Contact** (FBC) or **Partial Body Contact** (PBC) criteria were established to maintain and protect water quality for activities such as swimming, water skiing, boating, and wading. The FBC criteria are to protect public health when people engage in full immersion in the water and potential ingestion. The PBC criteria are to protect people who engage in water-based recreation where full immersion and ingestion of the water are unlikely (wading, fishing, boating).



- **Fish Consumption** (FC) water quality criteria were established to protect human health from pollutants which may bioaccumulate in aquatic organisms (e.g., fish, turtles, crayfish) and be consumed by people.

Domestic Water Source (DWS) criteria are applied to surface water that is used as a raw water source for drinking water supply. The criteria were developed assuming that conventional water treatment (disinfection and filtration) would be needed to yield water suitable for human consumption.



- **Agriculture Irrigation** (AgI) criteria were established to protect water used for irrigating crops.
- **Agriculture Livestock Watering** (AgL) criteria were established to safeguard water used for consumption by livestock.

Narrative Standards -- Narrative surface water standards (A.A.C. R18-11-108) were established to protect water quality when a numeric standard is not available or is insufficient **(Appendix C)**. The new state TMDL statute requires development of narrative implementation procedures before narrative standards can be applied to 303(d) listing decisions. Several of these documents are under development but were not available for this assessment.

What changes have been made since the last assessment in 2002?

Surface water standards are reviewed and revised on a three-year cycle. These standards are established in Arizona Administrative Code (A.A.C.) R18-11-101 through R18-11-123 plus appendices. Ground water standards (A.A.C. R18-11-401 through R18-11-506) are revised as new drinking water protection standards are adopted.

Most of the changes in assessments were a result of the adoption of new surface water standards in 2002. These standards did not go into effect until after completion of the 2002 assessment, so this assessment is the first to use these new standards. The other significant change was the application of chronic standards for the Aquatic and Wildlife designated use. These changes are described below. The surface and ground water quality standards used in this assessment are included in **Appendix C**.

Turbidity and the New SSC Standard – Arizona repealed its turbidity standard in 2002 and adopted a suspended sediment concentration (SSC) standard to protect Aquatic and Wildlife designated uses. Turbidity is a qualitative measure of water clarity or opacity, while SSC is a quantitative measure of suspended solids. These two parameters represent two different ways to measure fine suspended particles such as clay, silt, organic and inorganic matter, plankton, and other microscopic organisms.

Arizona's new numeric suspended sediment concentration criterion is intended to protect fish in streams, with the exception of effluent-dominated streams. It is also not applicable to lakes. Arizona's SSC standard is set at 80 mg/L, expressed as the geometric mean of at least four samples. The new standard is only applicable to samples collected at or near base flow and does not apply to a surface water during or soon after a precipitation event.

To apply this standard for assessment purposes, it is necessary to calculate base flow for each site, which requires a large amount of flow data. Therefore, an assessment of SSC was usually possible only at or near USGS gaging stations, where an abundance of current and historical flow data is available.

At the gage sites, USGS flow data from the last 10 to 30 years, as available, were used to determine what range of flow values represented the stream "at or near base flow." Only SSC data collected within this range were used for the assessment. All SSC data collected at flows higher than this range were not considered. After the SSC data collected at or near base flow were assembled, an annual geometric mean was taken. Any stream with more than one exceedance of the geometric mean was assessed as "impaired" in accordance with the Impaired Water Identification Rule **(Appendix B)**. One exceedance was assessed as "inconclusive," and zero exceedances was "attaining."

Since the SSC standard was just recently adopted in 2002, a minimal amount of data were available for this assessment. Thus, ADEQ has continued to assess the turbidity standard repealed in 2002 in an effort to record potential suspended sediment problems. Additionally, these exceedances provide evidence of a potential narrative bottom deposit standard violation. The standard was assessed according to the methods described later in this chapter, and waters were either assessed as "attaining" or "inconclusive" due to turbidity. No 303(d) listings were made based on this parameter, since the standard was repealed. Any waters that would have been impaired or inconclusive under the former standard were called "inconclusive" and placed on the Planning List for further study.

It should be noted that EPA may place those waters that would have been impaired under the former standard on the 303(d) List, also citing the exceedances as evidence of a narrative standard violation. ADEQ cannot make 303(d) listings based on narrative standards violations until narrative standard

implementation procedures are adopted (procedures are currently being developed). A table showing all waters with significant turbidity and/or SSC exceedances appears in Chapter VI.

***Escherichia Coli* and Fecal Coliform Standards** – *Escherichia coli* is now Arizona's indicator of bacteria contamination for all surface waters, totally replacing fecal coliform standards after the 2002 triennial review. Whereas the former fecal coliform standards applied to all designated uses, the current *Escherichia coli* standards apply only to Full and Partial Body Contact uses. The Full Body Contact single sample maximum standard is now 235 colony forming units per 100 milliliters (CFU/100 ml), lower than the previous 580 CFU/100 ml, which resulted in several more waters being identified as "impaired." The Partial Body single sample maximum is set at 576 CFU/100 ml.

The new standards also replaced the application of a 30-day geometric mean (5-sample minimum), with a new four sample minimum geometric mean. The numeric value changed from 130 to 126. The new standard can be applied to any consecutive four samples and is not limited to those collected within 30 days.

The Impaired Water Identification Rule, however, which has not yet been revised since Surface Water Quality Standards changed, requires that listing decisions must be based on a 30-day geometric mean. Therefore, for this assessment the geometric mean standard of 126 could only be applied only when there were sufficient samples to determine a geometric mean within a 30-day period.

Designated Use Revisions – Designated uses were reviewed and several were revised during the last triennial review of Arizona's water quality standards. The predominant change was the result of research completed by ADEQ's Biocriteria Program that showed that aquatic communities change from warmwater to coldwater consistently around the 5,000-foot elevation in Arizona. Based on this research, many streams specifically listed in Arizona's Surface Water Quality Standards for Surface Waters were split: coldwater above the 5,000-foot line (A&Wc) and warmwater (A&Ww) below. (The reach numbers remained the same, except that an "A" was attached to the upper coldwater portion and "B" to the downstream warmwater portion.)

Modifications made to the Tributary Rule (A.A.C. R18-11-105) changed the designated uses assigned to all surface waters not named in Appendix B of the standards. These streams or lakes are no longer assigned Agricultural Irrigation, Agricultural Livestock Watering, or Domestic Water Source uses. The waters are assigned Aquatic and Wildlife, Fish Consumption, and Body Contact uses as follows:

- Ephemeral waters are assigned the Aquatic and Wildlife ephemeral and Partial Body Contact uses only.
- Perennial and intermittent waters are assigned the Aquatic and Wildlife coldwater use if above 5,000 feet, and warmwater if below 5,000 feet. The Fish Consumption and Full Body Contact uses are assigned to all perennial and intermittent waters.

Changes in Other Standards – A number of other standards were significantly changed by the adoption of the new standards in 2002. Among those, the following changes resulted in several additions or delistings to the 303(d) List or the Planning List:

- The beryllium standards for Fish Consumption changed from 0.21 µg/L to 1,130 µg/L;
- The fluoride standards to protect Full and Partial Body Contact changed from 8,400 µg/L to 84,000 µg/L;
- A new lead standard to protect Full and Partial Body Contact was established at 15 µg/L (no standard previously for these uses);
- The manganese standards to protect Full and Partial Body Contact changed from 19,600 µg/L to 196,000 µg/L.

Application of Chronic Standards -- The 2004 assessment is the first to apply chronic standards for the Aquatic and Wildlife designated use using the requirements of the Impaired Water Identification Rule (**Appendix B**, R18-11-605.D.2.b). In accordance with the rule, a surface water is assessed as "impaired" if more than one exceedance of an Aquatic and Wildlife chronic water quality standard occurs. Although a geometric mean of the last four samples must be taken to apply the standard for enforcement purposes, the Impaired Water Identification Rule requires only two exceedances to be placed on the 303(d) List, with no minimum sample size or application of a geometric mean.

Acute and Chronic Standards

Some water quality parameters have both an "acute" and a "chronic" standard (**Appendix C**). Acute standards are set at higher concentrations than chronic standards, to protect aquatic life and wildlife from short-term exposures to the parameter of concern. Chronic standards are set at lower concentrations than acute standards, to protect aquatic life and wildlife from long-term exposure.

Do some waters have special standards to meet?

Unique Waters Classification and Antidegradation Standards – A Unique Water is a surface water classified by ADEQ as an outstanding state resource water (as prescribed in A.A.C. R18-11-112). Twenty streams have been established as Unique Waters in Arizona **(Figure 11)**.

ADEQ may classify a surface water as a unique water through the rule making process if it meets one of the following criteria:

- The surface water is of exceptional recreational or ecological significance because of its unique attributes, including but not limited to attributes related to the geology, flora, fauna, water quality, aesthetic values, or wilderness characteristics of the surface water, or

- Threatened or endangered species are known to be associated with the surface water and existing water quality is essential to the maintenance and propagation of a threatened or endangered species, or the surface water provides critical habitat for a threatened or endangered species.

Public comments in support or opposition to a Unique Waters nomination are considered by the Department in making the decision on classifying a water as meeting one or both of these criteria.

Unique waters are given more stringent surface water quality protections than other surface waters under the state's antidegradation rule A.A.C. R18-11-107(D). Under antidegradation implementation procedures, activities that may result in a new or expanded discharge of pollutants to Unique Water (or its tributaries) are prohibited if the discharge would cause degradation of existing water quality. Discharges include those caused by land use activity (e.g., construction, mining, grazing, agriculture) as well as discharges requiring a surface water discharge permit (e.g., wastewater treatment plant discharge, adit, dredge and fill activity).

Additional, more stringent, numeric standards can be specified for Unique Waters. These site specific standards are listed in the surface water standards (A.A.C. R18-11-112).

Effluent Dependent Water – ADEQ classifies some waters as effluent dependent waters **(Figure 12)**. These surface waters would be ephemeral, except for the discharge of treated effluent. Designated uses are limited to Aquatic and Wildlife effluent dependent water, Partial Body Contact, and in some places Agriculture Livestock Watering.

Arizona has developed specific Aquatic and Wildlife effluent dependent water (A&Wedw) standards for bacteria, water temperature, dissolved oxygen, and acute and chronic toxic chemical criteria **(Appendix C)**. In general, these standards are less stringent than other Aquatic and Wildlife designated uses due to the limited species of aquatic life that these waters can support. The exception is *Escherichia coli*, which is more stringent because of the likelihood of pathogens in wastewater.

Moderating Provisions – Dischargers have the opportunity to establish a "mixing zone" or "variance" through the NPDES/AZPDES permit process. These moderating provisions provide an alternate standard for the surface water.

- A mixing zone is a prescribed area or volume of surface water where initial dilution of the discharge takes place. A mixing zone can only be established if there is adequate water for dilution; therefore it cannot be applied to an ephemeral drainage.
- ADEQ can also grant a pollutant specific variance for a point source discharge for up to five years where:

  < The permittee demonstrates that the treatment is more advanced than the technology-based effluent limitations needed to comply with the water quality standards, but
  < It is not technically feasible to achieve this level of treatment within the next five years, or the cost of such treatment would result in unacceptable social and economic impacts.
  < Human-caused conditions or sources of pollution prevent attainment of the water quality standard and cannot be remedied within the next five years.

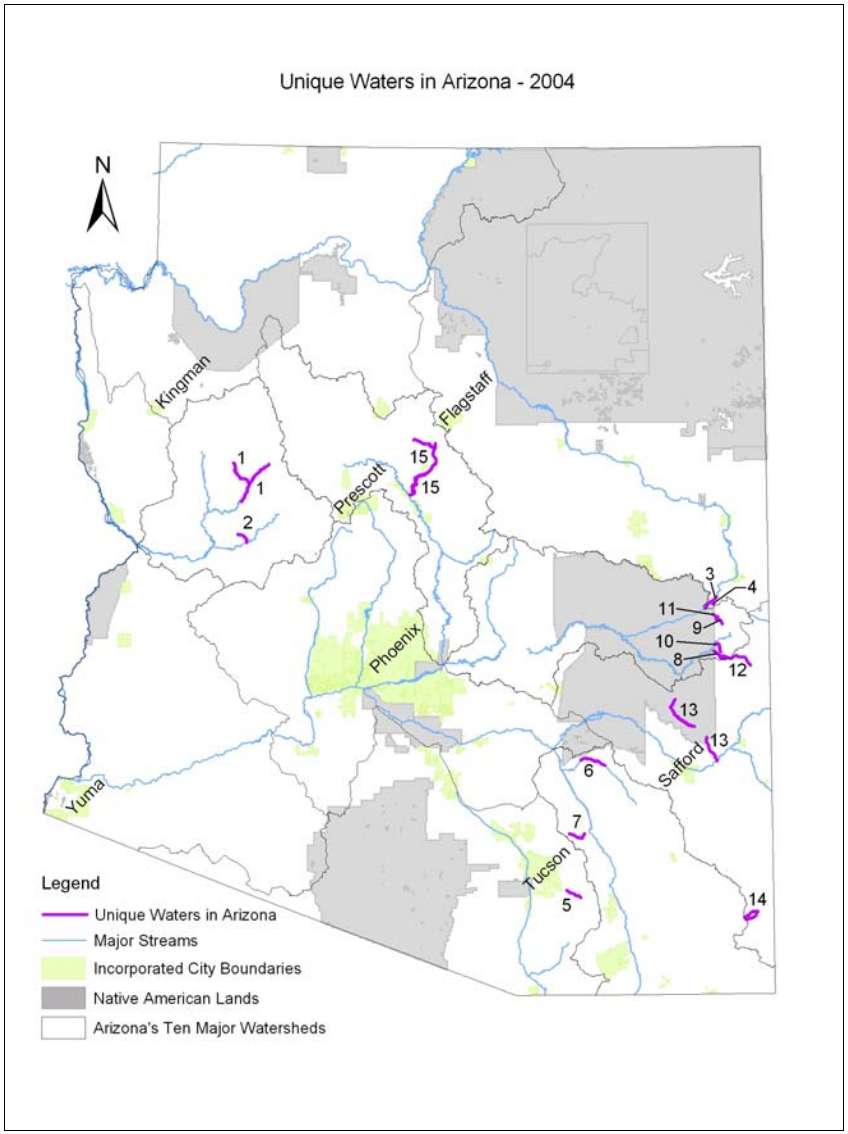


Figure 11. Unique Waters in Arizona

Map #	Stream Names and Reaches	ID Numbers
1	Burro Creek -- above confluence with Boulder Creek	AZ15030202-011 AZ15030202-009 AZ15030202-008
1	Francis Creek -- in Mohave and Yavapai Counties	AZ15030202-012
2	Peeples Canyon Creek -- tributary to the Santa Maria River	AZ15030203-524
3	Little Colorado River, West Fork of the Little Colorado -- above Government Springs	AZ15020001-013A
4	Lee Valley Creek -- headwaters to Lee Valley Reservoir	AZ15020001-232A
5	Cienega Creek -- Gardner Canyon to USGS gage station (Pantano Wash)	AZ15050302-006B
6	Aravaipa Creek -- Stowe Gulch to downstream boundary of Aravaipa Canyon Wilderness Area	AZ15050203-004B
7	Buehman Canyon Creek -- headwaters to 9.8 miles downstream	AZ15050203-010A
8	Bear Wallow Creek -- headwaters to San Carlos Indian Reservation	AZ15060101-023
8	Bear Wallow Creek, North and South Forks	AZ15060101-022 AZ15060101-258
9	Hay Creek -- headwaters to West Fork of Black River	AZ15060101-353
10	Snake Creek -- headwaters to Black River	AZ15060101-045
11	Stinky Creek -- Fort Apache Indian Reservation to West Fork of the Black River	AZ15060101-352A
12	KP Creek -- headwaters to Blue River	AZ15040004-029
13	Bonita Creek -- tributary to the upper Gila River	AZ15040005-032 AZ15040005-030
14	Cave Creek and South Fork of Cave Creek -- headwaters to Coronado National Forest boundary	AZ15040006-852A AZ15040006-849
15	Oak Creek, including West Fork of Oak Creek	AZ15060202-019 AZ15060202-018 AZ15060202-017 AZ15060202-016 AZ15060202-020

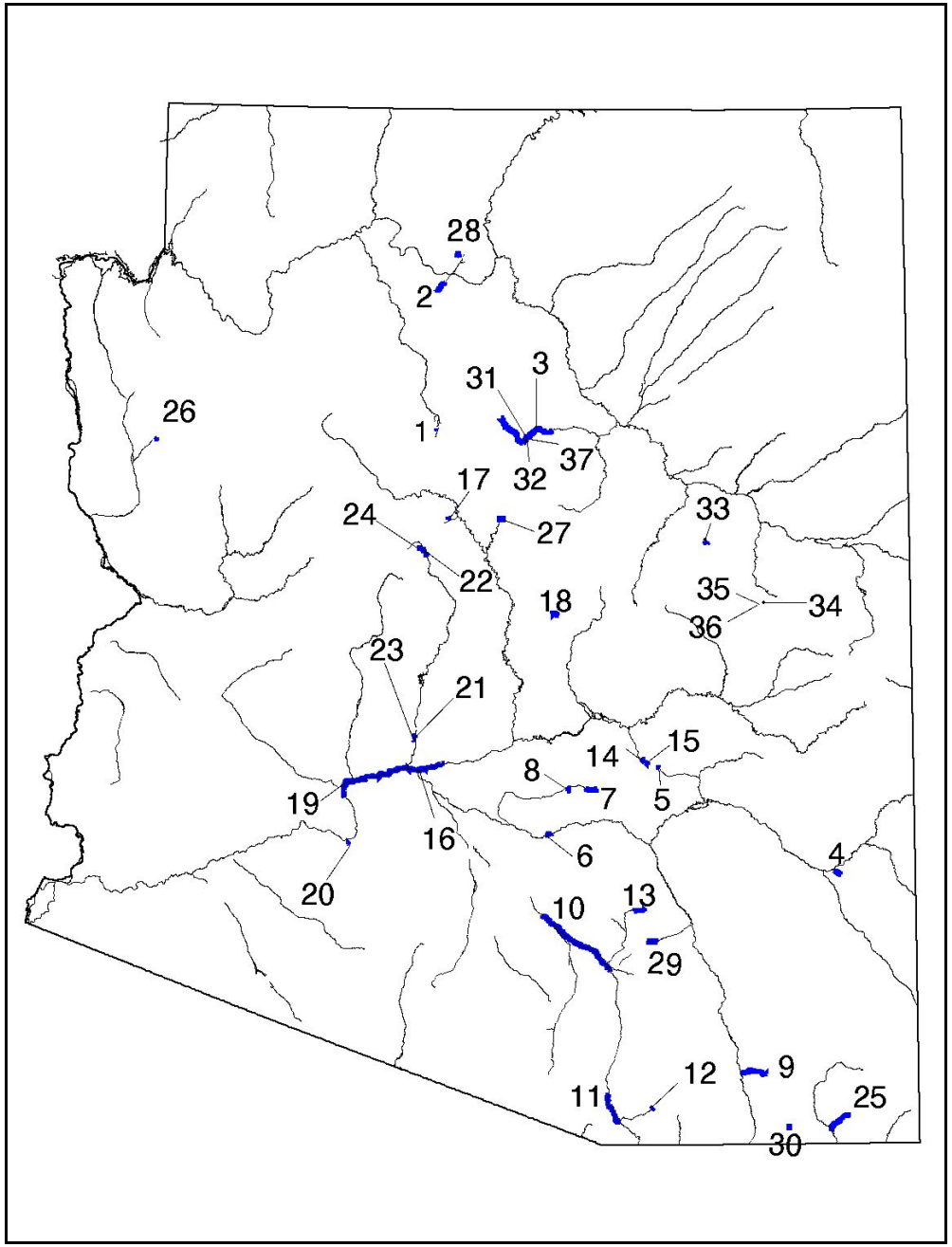


Figure 12. Effluent Dependent Waters in Arizona

(See table of surface water names on the following page)

Effluent Dependent Waters in Arizona (for Figure 12)

Map #	Surface Water Name and Wastewater Treatment Plant (WWTP)	Map #	Surface Water Name and Wastewater Treatment Plant (WWTP)	Map #	Surface Water Name and Wastewater Treatment Plant (WWTP)
1	Cataract Creek below Williams WWTP to 1 km downstream	16	Salt River below Phoenix 23rd Avenue WWTP (Phoenix metro WWTPs) to Gila River	31	Lake Humphreys from Flagstaff WWTP
2	Bright Angel Wash below So Rim of Grand Canyon WWTP to Coconino Wash	17	Bitter Creek below Jerome WWTP to Indian Reservation	32	Whale Lake from Flagstaff WWTP
3	Rio de Flag below Flagstaff WWTP to San Francisco Wash	18	American Gulch below the No. Gila County WWTP to E. Verde River	33	Dry Lake from Stone Container WWTP
4	Bennett Wash below ADOC*-Safford WWTP to Gila River	19	Gila River below #16 to Gillespie Dam (Phoenix metro WWTPs)	34	Pintail Lake from Show Low WWTP
5	Unnamed wash below ADOC*-Globe WWTP to Indian Reservation	20	Unnamed wash from Gila Bend WWTP to Gila River	35	Telephone Lake from Show Low WWTP
6	Gila River below Florence WWTP to Felix Rd.	21	Agua Fria River below El Mirage WWTP to 2 km downstream	36	Ned Lake from Show Low WWTP
7	Queen Creek below Superior WWTP to Potts Canyon	22	Agua Fria River below Prescott Valley WWTP (#24)	37	Lower Walnut Canyon Lake from Flagstaff WWTP
8	Unnamed wash below Queen Valley WWTP to Queen Creek	23	Unnamed wash below Luke Air Force Base WWTP to Agua Fria River	38	Lake Cochise south of Twin Lakes Golf Course
9	Walnut Gulch below Tombstone WWTP to Tombstone Wash	24	Unnamed wash below Prescott Valley WWTP to Agua Fria River		
10	Santa Cruz River below Pima County Roger Rd. WWTP to Baumgartner Rd.	25	Unnamed wash to Whitewater Draw below Bisbee Airport WWTP)		
11	Santa Cruz River below Nogales International WWTP to Tubac bridge	26	Holy Moses Wash below Kingman WWTP to 3 km downstream		
12	Sonoita Creek below Patagonia WWTP to 750 ft. downstream	27	Jack's Canyon Wash below Big Park WWTP to Dry Beaver Creek		
13	Unnamed wash below Oracle WWTP to 5 km downstream	28	Transept Canyon below No. Rim Grand Canyon WWTP to 1 km downstream		
14	Pinal Creek below Globe WWTP (#15) to Radium	29	Unnamed tributary to Alder Wash below Mount Lemmon WWTP		
15	Unnamed wash below Globe WWTP to Pinal Creek	30	Mule Gulch below Bisbee WWTP to Highway 80 bridge		

* ADOC = Arizona Department of Corrections

Arizona's assessment criteria

Most of Arizona's assessments are based on numeric water chemistry data. To determine whether there are sufficient data and that the data are representative of the surface water being assessed, the following attributes must be considered: core parametric coverage, number of samples, number of sampling events, seasonal distribution of samples, and sample locations. The criteria for assessment are described in the following paragraphs.

Core Parametric Coverage – Although all parameters with numeric standards are used for this assessment, a core set of parameters was established for each designated use (**text box**). These core parameters must be sampled during at least three independent sampling events to determine whether a specific designated use assigned to the surface water is "attaining."

Core parameters were selected based on EPA guidance in the draft *Consolidated Assessment and Listing Methodology* (CALM) document (EPA, 2001). This guidance places emphasis on narrative standards, suggesting that core indicators would include: bioassessments, habitat assessments, ambient toxicity testing, contaminated sediment, health of individual organisms, nuisance plant growth, algae, sediments, and odor and taste.
Arizona's choice of core indicators has changed slightly due to standards changes and more recent water quality research. Dissolved chromium was dropped from Aquatic and Wildlife, and total chromium was added to Domestic Water Source. Lead was also added to Domestic Water Source. Metals were dropped from Full and Partial Body Contact. Core parameters will continue to change in the future as better assessment tools and criteria are developed.

Core Parametric Coverage

For each designated use, at least three samples of the following parameters are required to assess the designated use as "attaining" uses:

Aquatic and Wildlife: dissolved oxygen, flow (if a stream) and depth (if a lake), hardness, pH, turbidity/suspended sediment concentration, total nitrogen and total phosphorus[1], dissolved metals (cadmium, copper, and zinc)

Fish Consumption: total mercury

Full Body or Partial Body Contact: *Escherichia coli*, pH

Domestic Water Source: nitrate/nitrite or nitrate, pH, total fluoride, and total metals (arsenic, chromium or chromium VI, and lead)

Agriculture Irrigation: pH, total boron, and total manganese

Agriculture Livestock Watering: pH, total copper, and total lead

Special notes:
1. Nitrogen and phosphorus are required only in surface waters with nutrient standards.
2. Dissolved oxygen, turbidity/SSC, and Escherichia coli are not required in ephemeral waters.
3. Suspended sediment concentration is not required in effluent dependent waters.

Exempted Exceedance of Standards – Some exceedances are specifically exempted in Arizona's surface water standards or Impaired Water Identification Rule **(Appendix B and C)**. In these cases, the exceedances would be noted in the monitoring tables, but not used as evidence of impairment:

- Naturally-occurring conditions (A.A.C. R18-11-119). For this assessment, the naturally-occurring conditions exempted included:
  - < Low dissolved oxygen occurring due to documented ground water upwelling;
  - < Areas minimally impacted by human activity, where springs are the source of a pollutant due to natural deposits; or
  - < Minimally impacted drainage areas, such as a small drainage in the Grand Canyon National Park, where excess turbidity is due to natural erosion of sandstone geological formations.
- Operation and maintenance of a canal, drain, or municipal park lake (e.g., dewatering, dredging, and weed control) (A.A.C. R18-11-117);
- Routine physical or mechanical maintenance of dams and flood control structures may cause increases in turbidity (A.A.C. R18-11-118); and
- Discharge of lubricating oil associated with start-up of well pumps which discharge to canals (A.A.C. R18-11-117).

Note that some waters are not defined as a "surface water" in Arizona's Surface Water Quality Rules (e.g., wastewater treatment lagoons or impoundments). Surface water quality standards would not apply to these waters.

Spatial and Temporal Considerations – To determine whether there are sufficient samples and sampling events to support an assessment, first it must be determined that the samples are spatially and temporally independent, as required by the Impaired Water Identification Rule (A.A.C. R18-11-603). Samples are spatially independent if they are collected more than 200 meters apart; or if collected less than 200 meters apart, samples were taken to characterize the effect of an intervening tributary, outfall, pollution source, or significant hydrographic or hydrologic change. Samples are temporally independent if they are collected more than seven (7) days apart.

If samples are neither spatially nor temporally independent (e.g., samples taken at different depths in a lake), the data will be represented by a calculated value.

The method for calculating these values varies by type of surface water standard. If the standard was established to protect from immediate or acute impacts, then a maximum or worst case value for the data set is used. Examples of standards developed for acute exposures include: dissolved metals, chlorine, dissolved oxygen, and ammonia (some of these have chronic standards as well). However, if the standard was developed based on concern for lifetime or long-term exposure, then an appropriate measure of central tendency (e.g., mean, median, geometric mean) is used. Most standards that protect domestic water source, fish consumption, and agricultural uses fall into this second category.

Some surface water quality standards are evaluated by number of sampling events, rather than number of samples. Parameters that must be assessed in this manner are the acute and chronic standards for the Aquatic and Wildlife designated uses, the *Escherichia coli* standard for the Full and Partial Body Contact designated uses, and the nitrate standard for the Domestic Water Source use. An assessment is made based on sampling event, where more than one sampling event exceeding standards is assessed as "impaired." In other words, if an exceedance occurred at multiple sample sites on a reach within a 7-day period, these data are evaluated as one sampling event exceeding standards. In the monitoring tables, event exceedances are indicated in the summary row for each reach or lake.

Adjustments due to Testing Precision – Field measurements and certain analytical methods are sometimes less precise than other water quality measurements. Imprecision due to error are addressed through quality assurance/quality control procedures (e.g., calibration of the field equipment, placement of the instrument in the stream, holding temperatures); however, other variations are inherent in natural systems, equipment specifications, and analytical methods.

When a field sample measurement is within the manufacturer's specification for accuracy, the result is considered to meet the surface water quality standard. For the 2004 listing cycle, three field measurements were adjusted due to the following manufacturer specification's concerning precision:

- pH is ± 0.2 standard units,
- Dissolved oxygen is ± 0.2 mg/L, and
- Turbidity is ± 2 NTU.

For example, dissolved oxygen reported at 5.9 mg/L was not counted as a violation of the 6.0 mg/L standard (range 5.8 - 6.2).

Both lab and field bacterial analysis provide an estimation of bacterial density, reported in terms of Most Probable Number (MPN). For example, using the multiple tube technique, if the result is reported as 240 colony forming units (CFU), there is a 95% confidence level that the result is between 100 and 940 CFU (*Standard Methods for Examination of Water and Wastewater, 20th Edition*).

For the 2004 listing cycle, the imprecise nature of bacteria samples were considered when a 303(d) Listing decision would be based on results reported relatively near the single sample maximum standard of 235 CFU. Generally, a 303(d) Listing can result from only two (2) exceedances of the single sample maximum bacteria standard within a three-year period. However, when one of the two samples was near the standard (for example, only 240 CFU), the exceedances were considered "inconclusive" and did not result in a listing.

Assessment of each Designated Use (Step 1) – The following criteria are applied to assess the individual designated uses assigned to the surface water in rule:

- **Attaining** – A designated use is assessed as "attaining" if:

A. For most standards (except situations in B, C, and D below),
   1. Three or more temporally independent sampling events for all core parameters (see core parameters discussion above), collected across multiple seasons, and
   2. No exceedances, or
   3. If exceedances, 10 or more samples and fewer exceedances than would place the water on the Planning List (based on Table 1 in the Impaired Water Identification Rule).

B. For acute Aquatic and Wildlife standards, the nitrate and nitrite/nitrate standard, and single sample maximum bacteria standards,
   1. Three or more temporally independent sampling events for all core parameters, collected across multiple seasons, and
   2. No exceedances, or
   3. If exceedances, three years of samples since last exceedance.

C. For chronic Aquatic and Wildlife standards,
   1. Three or more temporally independent sampling events for all core parameters, collected across multiple seasons, and
   2. No exceedances.

D. For an annual mean (nutrients), 90th percentile (nutrients), or geometric mean (Escherichia coli or SSC), no exceedances within the assessment period.

- **Impaired** – A designated use is assessed as "impaired" if:

A. For most standards (except situations in B, C, and D below),

1. 20 or more samples with the minimum number of exceedances listed in Table 2 (the 303d List) in the Impaired Water Identification Rule, and
2. Collected during three or more temporally independent sampling events.

B. For acute Aquatic and Wildlife acute standards, the nitrate and nitrite/nitrate standard, and single sample maximum bacteria standards)

1. More than one exceedance **during temporally independent sampling events** within a 3-year period, and
2. Fewer than three years of samples since last exceedance.

C. For Aquatic and Wildlife chronic standards:

1. More than one exceedance during temporally independent sampling events.

D. For an annual mean (nutrients), 90th percentile (nutrients), or geometric mean (Escherichia coli or SSC),

1. More than one exceedance within the assessment period.

- **Not attaining** -- A designated use is assessed as "not attaining" if it would be "impaired" except that:

A. A TMDL has been approved by EPA and TMDL implementation is ongoing, but the surface water is not yet attaining its designated uses;
B. Another action is occurring and documented that is expected to bring the surface water to "attaining" by the next assessment; or
C. Investigation shows that impairment is due to pollution and not a pollutant. (For example, investigation reveals that lake low dissolved oxygen and pH problems are not due to nutrient loadings but are solely due to the lack of flow.)

- **Inconclusive** – A designated use is assessed as inconclusive if:

A. Insufficient samples, exceedances, or core parameters to assess as "attaining," "not attaining," or "impaired" (see above),
B. Samples collected did not meet credible data requirements,
C. There is potential evidence of a narrative violation (i.e., fish kill, beach closure, fish anomalies, **exceedances of the former turbidity standard**, fish advisory, etc.)
D. Potential exceedance of the suspended sediment concentration standard (see discussion of page III - 3).

Assessment of the Stream Reach or Lake (Step 2) – Once each designated use is assessed, the assessments are combined into an overall assessment of the stream reach or lake. A stream reach or lake can be placed into one of the following categories:

- **Attaining All Uses –** All designated uses assessed as "attaining" (category 1);
- **Attaining Some Uses** – At least one designated use assessed as "attaining" and all other uses assessed as "inconclusive" (category 2);
- **Inconclusive** – All designated uses are "inconclusive" (category 3) (By default, any surface water not assessed due to lack of credible data is actually included in this category);
- **Not attaining** -- At least one designated use is "not attaining," and no designated use is "impaired" (category 4).
- **Impaired –** At least one designated use was assessed as "impaired" (category 5).

Surface waters in category 5 are placed on the 303(d) List and scheduled for TMDL development. Surface waters with any designated uses assessed as "inconclusive" or "not attaining" are placed on the Planning List for further monitoring.

The flow chart **(Figure 14)** on page 13 helps to illustrate these two steps of the assessment process.

The use assessments are made in Chapter IV and combined for an overall assessment of designated uses. Then the surface waters are placed in one of the five category lists in Chapter V.

Which "Cottonwood Wash" and how much was assessed?

To communicate assessment information and eliminate the ambiguity caused by many streams in Arizona having the same common name (e.g., Sycamore Creek) and a large number of unnamed washes, all of the assessed lakes and streams have been given identification numbers. These numbers are based on the drainage area in which the surface water is located (Hydrologic Unit Code area -- see chapter II) and a reach or lake number. These identification numbers can be linked to a digitized hydrography through a computerized Geographic Information System (GIS). When assessment are complete ADEQ will provide the assessment information to EPA along with GIS coverages which indicate where the assessed lakes and streams are located. These linkages were also used in this report to generate the assessment maps provided in Chapter IV.

Arizona assesses an entire surface water "reach" or lake based on one or more monitoring sites **(Figure 13 and text box)**. As more monitoring data become available, differences in water quality in portions of a reach or a lake may become apparent, and the reach or lake is segmented. This has frequently occurred during TMDL investigations, as the extent of contamination becomes more defined.

Reaches are also routinely divided due to changes in designated uses. The revised water quality standards adopted in 2002 recognized that aquatic communities change from coldwater to warmwater at a 5000-foot elevation; therefore, many reaches were split into coldwater and warmwater portions.

Figure 13. Reach Description

Reach Definition and Delineation

The US Geological Survey divided streams across the United States into drainage areas or Hydrologic Unit Code areas (HUCs). The Environmental Protection Agency then divided the streams into reaches based on hydrological features such as tributaries and dams, and provided a unique number for each stream reach. These reaches have been further divided by ADEQ due to changes in designated uses, hydrology, and documented changes in water quality. In **Figure 14**, 15060202 is the HUC and 028 is the reach.

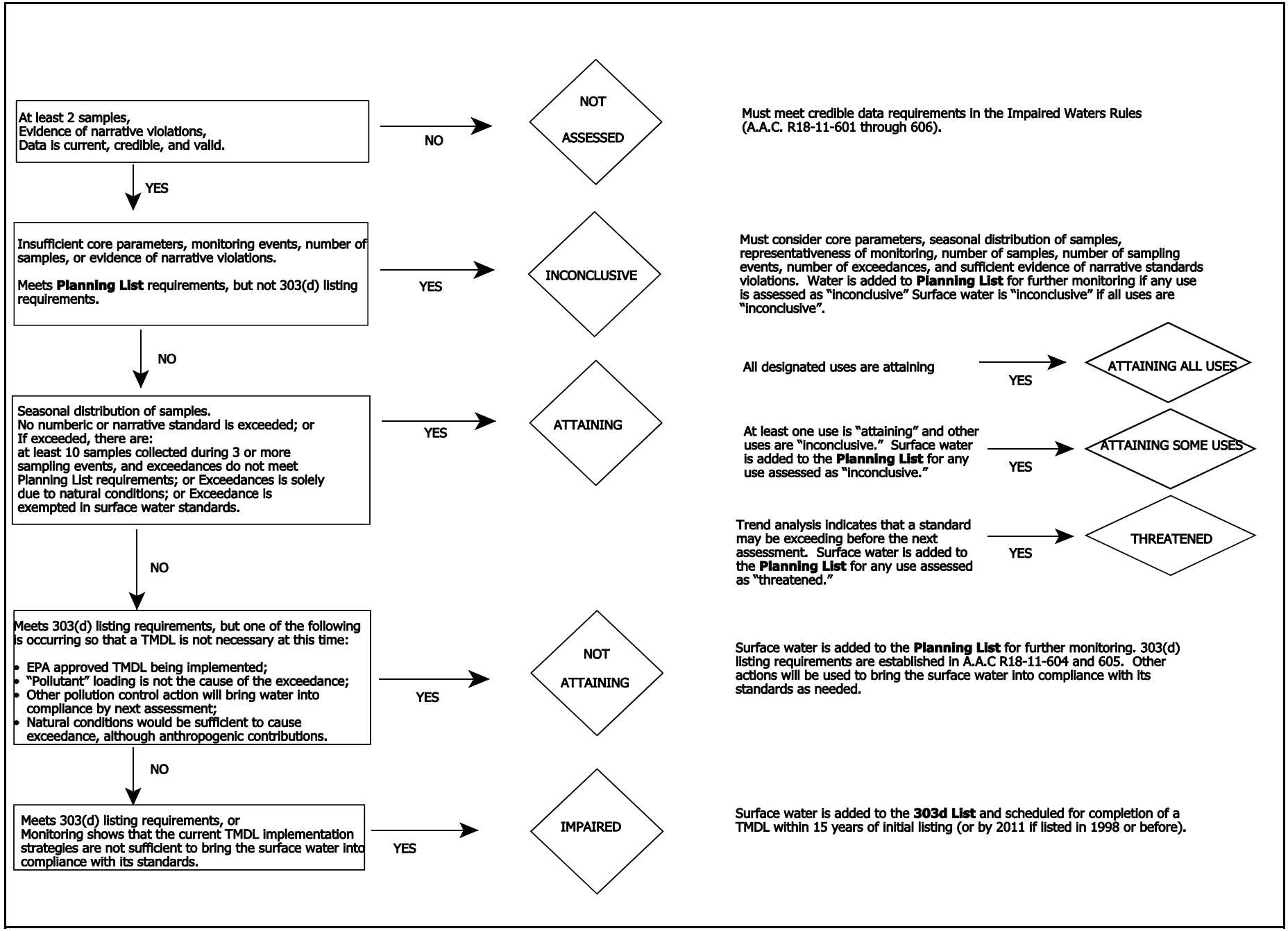


Figure 14. 2004 Assessment Process Diagram

How do lake and stream assessments differ?

The depth of a lake adds an additional level of complexity to an assessment. Samples are frequently collected at multiple levels in a lake because lower levels of a lake may have naturally higher chemical concentrations, especially when the lake is "stratified." Stratification is a natural process in which several horizontal water layers of different density may form in a lake. During stratification, the bottom layer (hypolimnion) is cool, high in nutrients, low in light, low in productivity, and low in dissolved oxygen. The top layer (epilimnion) is warm, higher in dissolved oxygen, light, and production, but normally lower in nutrients. The sharp boundary between the two layers is called a thermocline (metalimnion). Lake stratification is caused by temperature-created differences in water density.

Some measurements are more commonly taken in lakes or are used in a different way in lakes than in streams. For example, Chorophyll-*a*, Secchi depths, and volatile suspended solids results are compared to total suspended solids and turbidity values to determine whether excessive turbidity is actually related to a planktonic algal bloom and potential excessive nutrients or is related to suspended sediments and potential excessive lake sedimentation.

Trophic Status -- In addition to comparing water quality monitoring results with standards, ADEQ classifies lakes according to trophic status. Lakes are classified in a continuum of lake stages from low productivity to high productivity as nutrients accumulate or are depleted in the system.

Oligotrophic	Low algal or plant productivity
Mesotrophic	Medium algal or plant productivity
Eutrophic	High algal or plant productivity, and
Hypereutrophic	Very high algal or plant productivity and light-limited (Algae shades available light, inhibiting further growth)

A trophic classification is included in the assessment tables in Chapter V. The "Trophic Status Index" used in this assessment integrates phosphorus, nitrogen, Secchi depth, and Chlorphyll_*a* data, as indicated in **Table 6.** This trophic classification is based on: Brezonik, Patrick L. 1986. "Trophic State Indices: Rationale for Multivariate Approaches", *Lake and Reservoir Management*, USEPA, Office of Water. 440/5/84-001, pages 441-445. The Lakes Program is working on refining this trophic analysis in the future by accounting for macrophytes, algal diversity, and biovolume.

Given sufficient time, lakes go through a natural trophic progression accumulating nutrients and biomass. However, activities within the watershed may unduly speed up this process. It is important to note the hydrologic design and construction (e.g., shallow, with little water flow through) of most Arizona lakes may create management challenges such as high productivity and sedimentation.

Table 4. Trophic Classification Thresholds

	TROPHIC STATUS			
	Oligotrophic	Mesotrophic	Eutrophic	Hypereutrophic
Trophic Status Index	<30	30-45	45-65	>65
Chlorophyll-a (µg/L)	<5	5-12	12-20	>20
Secchi Depth (meters)	>3	1.2-3	0.6-1.2	<0.6
Total Phosphorus (mg/L)				
Phosphorus-limited	<10	10-20	20-35	>35
Nitrogen & Phosphorus-limited	<13	13-35	35-65	>65
Total Nitrogen (mg/L)				
Nitrogen-limited	<0.25	0.25-0.65	0.65-1.1	>1.1
Nitrogen & Phosphorus-limited	<0.28	0.28-0.75	0.75-1.2	>1.2

Nitrogen- limited = nitrogen : phosphorus ratio is <10.
Phosphorus-limited = nitrogen : phosphorus ratio is > 30.
Nitrogen and phosphorus-limited (colimited) = nitrogen : phosphorus ratio is 10-30

Can one get a copy of the data used for this assessment?

ADEQ continues to look for ways to share the data used in this assessment report with the public. Monitoring data are summarized in Chapter IV and are organized into tables by watershed. These summary tables indicate which agency and program collected the data, the amount and type of data, dates collected, frequency of exceedances, and more. Ambient surface water quality data collected by ADEQ staff can be obtained through EPA's STORET database on the internet at http://www.epa.gov/STORET.